ETSI GR MBC 001 V1.1.1 (2018-06)

Mobile Broadcast Convergence Group Report

Disclaimer

The present document has been produced and approved by the Mobile and Broadcast Convergence (MBC) ETSI Industry Specification Group (ISG) and represents the views of those members who participated in this ISG.
It does not necessarily represent the views of the entire ETSI membership.

Reference
DGR/MBC-001

Keywords
audio, broadband, broadcast, content, DVB, IMT, LTE-Advanced, mobile, multimedia, smartphone, UHDTV, video

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Mobile and Broadcast Convergence (MBC).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document discusses the potential of mobile - broadcast convergence for the distribution of audio-visual media content and services including linear broadcast radio and TV services serving the needs of end users, service providers and network operators.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Ericsson Mobility Report, June 2017.

[i.2] Ofcom: "The Communications Market Report", 4th August 2016.

[i.3] Ericsson Consumer and Industry Insight Report: "Experience Shapes Mobile Customer Loyalty", August 2016.

[i.4] Automotive Infotainment Systems Market Trends, Global Industry Analysts.

NOTE: Available at https://www.strategyr.com/MarketResearch/Automotive_Infotainment_Systems_Market_Trends.asp.

[i.5] 5G-PPP Whitepaper: "5G and Media & Entertainment", January 2016.

NOTE: Available at https://5g-ppp.eu/wp-content/uploads/2016/02/5G-PPP-White-Paper-on-Media-Entertainment-Vertical-Sector.pdf.

[i.6] Directive 2010/13/EU of the European Parliament and of the Council of 10 March 2010 on the coordination of certain provisions laid down by law, regulation or administrative action in Member States concerning the provision of audiovisual media services (Audiovisual Media Services Directive).

[i.7] LTE Broadcast Alliance White Paper: "LTE Broadcast - Lessons Learned from Trials and Early Deployments".

NOTE: Available at https://lte-broadcast-alliance.com/.

[i.8] Article 45-5 of draft Electronic Communication Code.

NOTE: Available at http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=comnat:COM_2016_0590_FIN.

[i.9] 3GPP TS 22.101 (V15.3.0) (12-2017): "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service aspects; Service principles (Release 15)".

[i.10] DTG PMP final report: "Enabling the future of personal media - anywhere, anytime - a cross-industry collaboration".

NOTE: Available at http://www.digitaltvgroup.com/dtg/pmp_report_2-1.pdf.

[i.11] Ilsen S., Juretzek F., Lucca R., Rother D.: "Tower Overlay over LTE-Advanced+ (TOoL+) - Results of a Field Trial in Paris", IEEE™ 2016 BMSB -Nara, Japan conference.

[i.12] Ilsen S., Rother D., Juretzek F., Bretillon P., Seccia J., Ripamonti S.: "Tower Overlay over LTE-Advanced+ (TOoL+) - Field Trial Results", IEEE™ 2015 ICCE-Berlin conference.

[i.13] ATSC 3.0 Transition and deployment guide, chapter Advertising/Monetisation page 42-43.

NOTE: Available at http://info.gatesair.com/atsc-3.0-guide-download.

[i.14] Wireless distribution in the future media landscape Broadcast-like services - Per Bjorkman, Head of Distribution, SVT.

NOTE: Available at http://www.etsi.org/component/rsfiles/files?folder=2015+Wireless+media+distribution+beyond+2020%5CFUTURE+MEDIA+LANDSCAPE.

[i.15] DVB Fact sheet on DVB T2 (including T2 Lite).

NOTE: Available at https://www.dvb.org/resources/public/factsheets/dvb-t2_factsheet.pdf.

[i.16] ATSC 3.0 transition and deployment guide, chapter Hybrid services page 38.

NOTE: Available at http://info.gatesair.com/atsc-3.0-guide-download.

[i.17] ATSC 3.0 Brings Flexibility of IP to Broadcast.

NOTE: Available at https://www.tvtechnology.com/atsc/atsc-30-brings-flexibility-of-ip-to-broadcast.

[i.18] HbbTV: "Information about and History of HbbTV 2.0 Specification".

NOTE: Available at https://www.hbbtv.org/wp-content/uploads/2015/07/Information-about-and-History-of-HbbTV-2.0-Specification.pdf.

[i.19] Digitaleurope White Paper on Supplemental Downlink in the UHF Band.

NOTE: Available at http://www.digitaleurope.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&entryID=893&language=en-US&PortalId=0&TabId=353.

[i.20] GSA report: "Evaluating the LTE Broadcast opportunity", November 2015.

NOTE: Available at https://gsacom.com/paper/evaluating-the-lte-broadcast-opportunity/.

[i.21] Recommendation ITU-R M.2083-0 (09/2015): "IMT Vision - Framework and overall objectives of the future development of IMT for 2020 and beyond".

[i.22] GSMA: "An introduction to 5G Network Slicing".

NOTE: Available at https://www.gsma.com/futurenetworks/wp-content/uploads/2017/11/GSMA-An-Introduction-to-Network-Slicing.pdf.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

NOTE: These terms and definitions are not mutually exclusive, i.e. an entity can be active in different areas at the same time.

Broadcast Network Operator (BNO): entity operating a broadcast network

Broadcast Service Provider (BSP): MSP providing linear television and/or radio services

Media Service Provider (MSP): audio-visual media service provider in the sense of the AVMS Directive [i.6]

Mobile Electronic Communication Service Provider (MECSP): entity providing mobile electronics communication services to customers

Mobile Infrastructure Operator (MIO): entity responsible for the technical operation a mobile network

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3rd Generation Partnership Project
5G-PPP	5G infrastructure - Public Private Partnership
ADSL	Asymmetric Digital Subscriber Line
ATSC	Advanced Television Systems Committee
AV	Audio-Visual
AVMSD	Audio-Visual Media Service Directive
BNO	Broadcast Network Operator
BSP	Broadcast Service Provider
CAGR	Compound Annual Growth Rate
CDN	Content Delivery Network
DL	DownLink
DTMB-A	Digital Terrestrial Multimedia Broadcast - Advanced
DTT	Digital Terrestrial TV
DVB	Digital Video Broadcasting
DVB-H	Digital Video Broadcasting - Handheld
DVB-T2 Lite	Digital Video Broadcasting - for mobile and portable reception
DVB-T2	Digital Video Broadcasting - Second generation Terrestrial
ECS	Electronic Communications Service
eMBMS	evolved Multimedia Broadcast Multicast Services
FEC	Forward Error Correction
FTA	Free To Air
HbbTV	Hybrid broadcast broadband TV
HEVC	High Efficiency Video Coding
HPHT	High Power High Tower
ICT	Information and Communications Technology
IMT	International Mobile Telecommunications
IP	Internet Protocol
IPTV	Internet Protocol TeleVision
IRT	Institut für Rundfunktechnik GmbH
ISDB-T	Integrated Services Digital Broadcasting - Terrestrial
ISP	Internet Service Provider
ITU	International Telecommunication Union
LTE	Long Term Evolution
LTE-B	Long Term Evolution - Broadcast
MBMS	Multimedia Broadcast Multicast Services
MECSP	Mobile Electronic Communication Service Provider

MediaFLO	Media Forward Link Only
MFCN	Mobile Fixed Communication Networks
MIO	Mobile Infrastructure Operator
MPEG	Moving Picture Experts Group
MSP	Media Service Provider
OTT	Ovet The Top
PPDR	Public Protection Disaster Relief
QoS	Quality of Service
SIM	Subscriber Identity Module
TDF	TéléDiffusion de France
T-DMB	Terrestrial - Digital Multimedia Broadcasting
TS	Technical Specification

4 Introduction

4.1 Context

Broadcast technologies and business models are currently unable to reach out to mobile devices due to several challenges, including the low penetration of broadcast technologies in mobile devices. Mobile unicast technologies and business models cannot deliver audio-visual services to mass audiences at fixed costs.

4.2 Defining convergence

Convergence can be interpreted as:

- **Convergence of network infrastructure:** This assumes a combined network infrastructure which incorporates different telecommunication technologies such as terrestrial, satellite, fibre and fixed links from one operator. Dynamic switching between different communication modes such as unicast, multicast and broadcast modes are exploited depending on network traffic and requested services. Routing of traffic through the different branches of the converged network infrastructure is an integral element of traffic management. Such a combined infrastructure is operated and controlled by a single entity.

- **Seamless interoperability:** This assumes the existence of distinct network infrastructure which nevertheless can seamlessly interoperate. Convergence in this case refers to the definition of the corresponding interfaces and common communication protocols. Routing of traffic is possible but requires corresponding peering relations. Control over content distribution lies with different entities in the distribution ecosystem.

- **Device based convergence:** This assumes that convergence takes place exclusively on the user device. The devices need to have a multitude of different network interfaces and the ability to connect to different networks at the same time. Appropriate software has to be provided to combine services received through different distribution means.

4.3 Benefits of convergence

Convergence is considered as having the potential to combine the benefits of current broadcast and mobile technologies and business models. Convergence is expected to create opportunities both to improve the delivery of current services and to deliver new services.

Convergence could improve the delivery of audio-visual media services to mobile devices, compared to the current situation. Different stakeholders can expect to benefit depending on the different convergence scenarios discussed in clause 8.

Convergence is also expected to create opportunities for new business models, for example:

- Individual/contextual advertising.

- Improved audience tools.

- Broadcast as a commercial platform leveraging MECSP billing.
- New form of TV services linked to mobility and interactivity.

5 Current trends and developments in audio-visual media distribution and consumption

5.1 Video on mobile devices

Users are increasingly consuming and generating video on mobile devices. The Ericsson Mobility Report [i.1] references the following points:

- Mobile video traffic over cellular networks CAGR from 2015-2021 is 55. Given the population distribution of developed countries, most of this demand is concentrated in densely populated areas.
- Mobile video is expected to account for approximately 70 % (35 EB/month) of mobile data traffic over cellular networks by 2021.
- 50 - 70 % of total mobile video traffic in most mobile networks is still dominated by a single player.
- In US, Japan and South Korea the growth (from July 2014 to October 2015) in average monthly video data is 80 % on cellular networks (0,48 GB in 2015) and 164 % on WiFi networks (3,09 GB in 2015).

Studies in the UK show similar growth in mobile video consumption, but note (see Table 1) the rapid growth in video calls that require similar uplink and downlink performance, according to The OFCOM Communications Market Report [i.2], Figure 4.46.

Table 1: Use of mobile data services among mobile users in the UK

Service	2014	2015	2016	Growth 2014-16
	Proportion of mobile users using services (%)			**Growth %**
Watch AV content	29	32	38	31
Watch video clips	25	26	33	32
Make video calls	15	18	24	60

5.2 Audio visual content delivery to vehicles

In addition to handsets, there are additional markets that are suited to delivery of content by mobile networks. For example, automotive TV exists in a niche environment today but demand for entertainment is expected to grow as vehicles increasingly become connected and autonomous.

Currently there is an active market for integrated and after-market automotive video equipment. Most of this market remains stored video, whereas the market for broadcast TV receivers, remains relatively niche rather than mainstream. The broadcast receiver markets are strongest where the TV network is planned for mobile reception (e.g. Germany) or countries that experience significant traffic congestion (e.g. Indonesia).

A vehicle is truly mobile and so a cellular network is the most suitable means of connectivity.

Figure 1 is a summary of several market forecasts showing how the automotive infotainment market is essentially flat (but the mix changes with a reduction in audio-only equipment and a growth in front-seat infotainment systems) but the embedded communications market is growing rapidly.

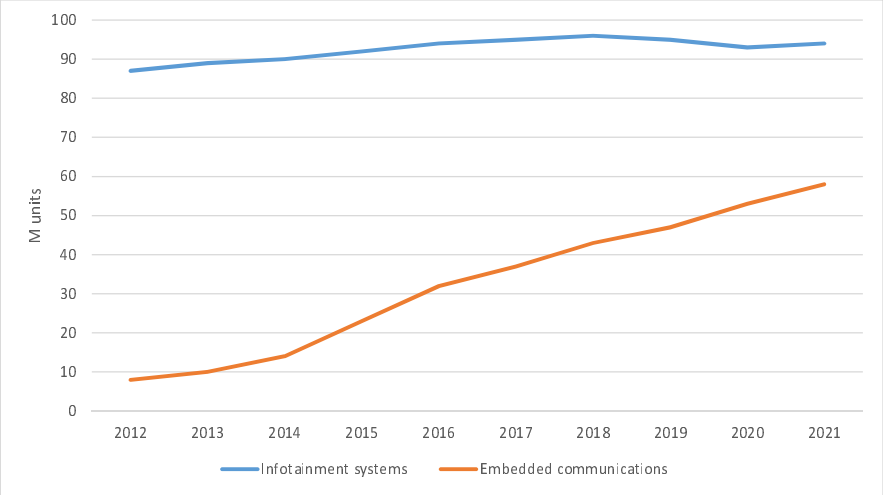

Figure 1: Market forecasts for automotive infotainment and embedded communications

The growth in embedded communications is not driven by delivery of broadcast TV to vehicles, but it demonstrates the opportunity for convergence [i.4].

5.3 Mergers and Acquisitions across the industry

There have been many mergers and acquisitions (M&A) across the telecommunications and mobile industry and the content/broadcast distribution sector for a variety of commercial reasons. Fixed telcos try to extend their reach in the content industry due to the value of broadcast content for a fixed internet access offering. Regardless of the reason, these M&As have increased the opportunity for mobile broadcast convergence from two separate angles:

- either one entity controlling content and a mobile network; or
- an entity controlling a heterogeneous network delivering both mobile and broadcast services, enabling a co-operative networking strategy.

Examples of this M&A or expansion of activity as of mid-2017 are:

- In Germany Freenet's acquired Media Broadcast and Vodafone acquired Kabel Deutschland.
- In the UK, BT acquired EE.
- In the US, AT&T acquired DirecTV and intends to acquire TimeWarner.
- In France, Numericable acquired SFR and Vivendi acquired Dailymotion.
- In Italy, Vivendi-Canal+ is said to control Telecom Italia with its 24 % stake.
- In Spain, Telefonica acquired DTS-Canal+.
- In Sweden, ComHem acquired Boxer TV Access.
- In New Zealand, Vodafone and Sky announced an internet TV deal.

Furthermore, there are BNOs involved in cellular networks, as evidenced by:

- Cellnex (formerly Abertis) and TDF's acquisition of mobile sites.
- Arqiva's operation of both a broadcasting and a cellular network.

There is some evidence that consumers prefer bundled services i.e. they like to take several telecommunications services from the same provider to enjoy either overall saving or a more straightforward management of their contracts. The service bundles raise the expectation in the consumer's mind that content can be consumed on a range of devices.

5.4 Growth in Mobile Video

There is mounting pressure on mobile networks to deliver growth in video delivery. New video streaming behaviour is placing different demands on a network's expected performance.

As the capability (display quality, codecs support, and computational power) of handsets has improved, the way the consumer judges the performance of the network has changed. For example, one third of users measure connectivity experience by video load time and buffering effects on streaming applications [i.3].

For example, a UK mobile network operator experienced a large increase in network traffic due to the England v. Wales football match during the Euro 2016 tournament. Given the match was during the afternoon of a normal working day, a large number of users obviously watched the match via their mobile network. The pressure on mobile networks is expected to strongly increase for the World Cup in 2018.

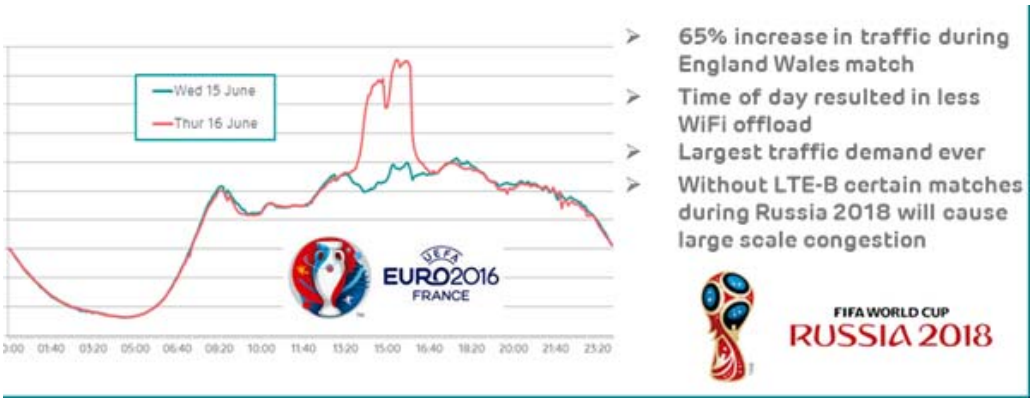

Figure 2: Increase in mobile network traffic during Euro 2016 football match (Source: BT/EE)

5.5 Meeting the growth in video demand

There are several ways of meeting this growth in video demand over mobile networks, the main ones are:

- Increasing network density
- Improving spectral efficiency
- Acquiring more spectrum
- Offloading traffic to WiFi or fixed networks or broadcast networks

Increasing the spectrum efficiency by increasing the network density is costly and requires significant investment. Use of broadcast services is one way of mitigating the need for additional spectrum or an increase in spectral efficiency if a significant portion of the usage is related to linear services.

Infrastructure sharing between MECSPs would be beneficial to cope with the growth of video traffic. However, for the time being existing regulation may not allow this due to the principle of infrastructure competition.

It is common practice for mobile network operators to actively off-load traffic to WiFi especially in association with a fixed network that they also control.

5.6 WiFi availability

WiFi is extensively used in homes, indeed estimates show that up to 85 % of video streaming is over WiFi at home [i.1]. WiFi is increasingly deployed in public places. It is being introduced in public transport, it is available in all user devices.

More than half of the commercial hotspots are controlled by players whose primary business is not telecommunications. Despite the growth in availability there remain many truly mobile only use-cases e.g. automotive and outdoors that can only be served by wide-area-networks.

5.7 Internet delivery

Internet distribution of content corresponds to a shift in the content distribution model. Traditional broadcast networks shared some attributes having an impact on the content provider business models, while internet based distribution offers different characteristics, as summarized in Table 2.

Table 2: Comparison of broadcast and unicast distribution

	Broadcast networks (Terrestrial, Satellite, Cable) or IPTV (ADSL, Cable, Fibre)	**Internet/unicast based distribution including WiFi**
Distribution coverage	Regulator may impose coverage of some platforms (e.g. FTA terrestrial or satellite). For platforms based on fixed network (Cable, fibre, IPTV), coverage subject to network reach.	Control either by end user or third party, typically very restricted coverage
QoS	Guaranteed.	Non-guaranteed, can be influenced by investing in CDN
Cost of access (access network)	Free-to-Air possible on different platforms based on regulatory decisions.	Covered by end customer => No possibility of Free-to-Air
Cost of distribution	Fixed cost irrespective of size of audience.	Distribution costs increase with the size of audience
Content prominence and findability	May be regulated or not.	No control
Content competition	Largely limited competition on national or regional basis.	Worldwide competition, mostly large internet players
Dominant content consumption	Linear content (TV).	Non-linear content

Both models provide benefits and drawbacks for BSPs. This has been identified with the rise of several platforms addressing fixed reception, such as HbbTV, combining a linear access channel (Terrestrial, Cable, Fibre, IPTV) and a non-linear access channel (internet/WiFi). These platforms are mostly available in the home environment where the user typically pays a monthly fee (e.g. for the fixed internet service and/or the TV service) to benefit from all the functionalities of the platform.

Replicating such a model in the mobile environment is more challenging due to the difficulty to replicate the linear broadcast channel, as discussed in clause 5.8. However, restricting content distribution to mobile devices to WiFi/Internet distribution, would have a significant impact on the content competition landscape.

5.8 Earlier mobile television technologies

Mobile broadcast delivery technologies have existed for a number of years, but with a few exceptions, they have not been widely adopted by the users. The technologies considered include DVB-H, MediaFLO, T-DMB, DVB-T2 Lite and e-MBMS.

Various reasons, commercial and technical, have been given for why these technologies were not successfully adopted. These are listed in Table 3 together with a comment on whether the situation has changed.

Table 3: Reasons why some earlier mobile broadcasting technologies failed to be adopted and whether things have changed today

Reason for failure	Situation today
No user demand for long-form, linear broadcast services on mobile devices	Demand for broadcast/streamed content delivered via mobile networks is still mostly for short-form content, apart from societal live events (e.g. sport, important news/events, concerts, etc.). Most users do store long form content (movies, series, etc.) on mobile devices to watch offline.
User did not associate video with mobile devices	The growth of smartphones improved resolution, bitrate, screen size and tablets.
Small, low-resolution, poor quality displays	Display are now larger with high resolution and high quality.
Dedicated network required	DVB-T2, ATSC 3.0 and LTE eMBMS now allow multiple modes to share same network.
MECSPs controlled spec of mobile phones in the market	Control of technology in mobile phones is shifting from MECSPs to OEMs, with more flexibility in the low to mid end market and severe restrictions in the high-end market.
Insufficient number of TV broadcast networks configured for mobile reception	This still remains the case. The network topology of cellular mobile networks is favourable for mobile reception. LTE eMBMS can be deployed as an add-on to a unicast network.
No global standard for TV broadcasting	This remains the case. 3GPP produces de facto global mobile standards and there is ongoing work in 3GPP to further develop existing broadcast functionality.
Cost of building a standalone network was prohibitive	The ability to add-on to existing deployed cellular networks opens up new opportunities.
Technical solutions did not enable new forms of cooperation	ATSC 3.0 and 3GPP technologies enable new forms of collaboration between mobile and broadcast stakeholders by combining linear and non-linear delivery in a single delivery platform. This opens the door for new revenues (e.g. targeted advertising).

There are (or have been) some commercial deployments of mobile broadcast technology:

- eMBMS is commercially deployed by Korea Telecom, Verizon Wireless and Reliance JIO. Telstra has rolled out a commercial service in 2018 around coverage of the Australian Football League.
- ISDB-T (1-segment version) in Japan:
  - Market supported by strong regulation and is free to air.
- T-DMB in Korea in mid-2000's:
  - Strongly supported by Korean CE vendors in the early years.
  - Still in regular use.

5.9 R&D activities in mobile TV

In recent years, several stakeholders have engaged in R&D activities related to the delivery of TV broadcasting to mobile devices.

In July 2014, BBC R&D in collaboration with EE, Huawei and Qualcomm demonstrated 4G Broadcast at its public Commonwealth Games Showcase in the Glasgow Science Centre. The demonstration used LTE eMBMS to broadcast live action from The Games to 4G mobile handsets - a first in the UK - to bring streaming TV to mobiles without buffering.

In April 2015 TDF and Rai launched the first field trials of an experimental enhancement of LTE eMBMS in Paris and Aosta. The joint project was based on the original "Tower Overlay" idea developed and implemented by Technische Universität Braunschweig (Germany) in 2013. The project involved contributions by GatesAir (USA) and was supported by IRT (Germany) and Expway (France).

The IMB5 research project, managed by the IRT, a consortium of Fraunhofer IIS, Friedrich-Alexander University Erlangen-Nuremberg, Nokia, Rohde & Schwarz and the associated partners Bayerischer Rundfunk and BMW Research and Technology, evaluated the development capacity of the LTE eMBMS broadcast mode with regard to the television signal transmission requirements. In 2014, the world's largest single-frequency network for LTE eMBMS went into operation at transmission sites of the Bayerischer Rundfunk in Munich.

Yle conducted an LTE eMBMS trial in partnership with the Finnish government, Nokia and Qualcomm, in September 2016.

The LTE-B Alliance was launched in 2016 to develop the LTE eMBMS ecosystem in anticipation of several additional commercial launches in 2017. They have published a paper referencing a number of relevant trials [i.7].

5.10 Broadcasters' engagement in 3GPP

Several TV broadcasters have engaged with the 3GPP standardization process in an attempt to ensure future 3GPP networks are suitable for broadcasting TV content. The motivation of TV broadcasters is to ensure 3GPP networks can be directly used and exploited. Corresponding activities are conducted both in the context of the EnTV work item (evolution of LTE broadcast with broadcast stakeholders' friendly features) and in the context of 5G (2025 onwards).

A list of requirements has been submitted to 3GPP by the TV broadcasters, see 3GPP TS 22.101 [i.9]. This requirement list includes the typical current requirements for a linear broadcast platform (such as DVB).

5.11 Relevant Technology Standards

Table 4: Recently standardized technologies or planned standardization relevant to MBC going forward (#3GPP forecasted date)

Technology	Type/Capability	Standard published
DVB-T2	Physical layer - fixed, mobile, hybrid broadcast	2009
ATSC 3.0	Physical layer - fixed, mobile, hybrid broadcast	July 2016
3GPP Rel. 9- 13	Physical layer - unicast/broadcast transport	2010 onwards
3GPP Rel.14	Physical layer - unicast/broadcast transport Further enhancement of eMBMS	June 2017
3GPP Rel.15	'5G Phase 1' release, for MBC this release may not be relevant in terms of radio access but rather in terms of core technology	June 2018#
3GPP Rel.16	'5G Phase 2' release, for MBC this release could potentially offer Multimedia Broadcast/Multicast Service improvements. *Subject to ratification in June 2018*	December 2019#
ISDB-T3	Digital broadcast technology with an associated mobile channel deployed in Japan and Brazil in previous releases	TBA
DTMB-A (China)	Chinese Standard GD/J 068-2015. Frame Structure, Channel Coding and Modulation for DigitalTelevision/Terrestrial Multimedia Broadcasting-Advanced (DTMB-A)	2015

6 Use cases

User expectations on choice, quality, convenience and costs of media services are driven by growing capabilities of user devices and distribution networks, the continuously increasing content offer, and the variety of ways that content and services are made available to the users.

Users so far experience a fragmented situation where broadcast services are available on some devices (typically large screen TVs) and mobile devices are used for other services (for example social media or on demand AV services). Also in terms of business models, linear broadcast services are typically provided as 'all you can eat', where mobile users typically have to be conscious of the data they consume, depending on the connectivity.

Ideally, convergence should enable users to access linear broadcast services:

- on mobile devices;
- without restriction on the amount consumed;
- free-to-air;
- with perfect delivery quality;
- in any environment.

The deployment opportunities addressed in clause 8 of the present document cover specific aspects of this central use case. In other words, the convergent solutions described are primarily aiming at delivering audio-visual media services to personal devices, in particular smartphones and tablets.

Deployment opportunities are also not restricted to this use case as they can enable additional services (e.g. social media, non-linear broadcast services) and consumption on other devices (e.g. large screen TV) or in complement of other devices (e.g. HbbTV). From an end-user perspective, the larger the number of use cases enabled or supported by a specific solution, the higher the attractiveness of such solution.

It is also a benefit if the functionalities enabling the use cases are available on a wide range of user devices. Users tend to select their devices based on multiple criteria, with the services that are enabled being just one of these criteria. Attractive devices are a prerequisite for any successful mass media service. Some of the deployment opportunities, in particular 2, 4, 6 and 8, outlined in clause 8, while primarily aiming at mobile devices, may have a potential to serve stationary devices equally well, either now or in the future.

The use cases enabled by a technology solution can be classified according to the main characteristics of the audio-visual media service delivered. These include:

- The type of service(s) and the time spent with different services
- The type of user device(s)
- The user context in which the service is consumed (e.g. in the home or on the move, indoors or outdoors)

There are many different types of audio-visual media services, user devices and situations in which a service can be used. For the purpose of this analysis the following categories are considered to be adequate as shown in Table 5.

Table 5: Service categories, device categories, user environment

Service categories	
Linear media services	A linear service is the traditional way of offering radio and TV services where the content is organized in a sequence that may consist of e.g. news, shows, drama, movies, or documentaries. That sequence is distributed as a stream of programmes that reach the viewer according to a pre-defined schedule. The viewer can tune in to a channel but cannot alter the schedule of programmes. Linear services are the most common way of viewing live content (e.g. sport events, concerts, news).
On-demand AV services	On demand audio-visual services require the user to take action beyond the simple selection of service as in the case of linear services. Typically, the user can select individual pieces of content from a library and can control at least the timing and sequence of the viewing or listening. Advanced on-demand services may offer many other options with various degrees of user engagement and interactivity. Particularly popular are time-shifted TV services (also known as 'TV on-demand' or 'catch-up TV') where the content that has been broadcast as linear TV is made available in a library for on-demand viewing within a certain time window (e.g. from 7 days to up to a year subject to content rights). Other forms of on-demand media services include streaming or download of content from a library, irrespective of whether or not it has been aired on linear channels. Push Video-on-Demand (or Push VoD) is a particular form of on-demand service where content is loaded on the user devices for future use. One variant is the PVR-based on-demand viewing, where the content is received as linear TV and recorded locally for future viewing. Furthermore, many additional options could be associated with the basic audio-visual content, such as second screen applications providing additional content, dedicated web and cross-platform content, integration with social networks. See note.
Device categories	
Mobile device	It is assumed that mobile user devices are the main target of the 3GPP-based infrastructure. It is further assumed that, in describing individual use cases, no distinction is required between smartphones and tablets. Most mobile devices have an uplink capability. However, 3GPP included a receive-only mode in the Release 14.
Stationary radio and TV set	It is assumed that a radio or a TV set is connected to an external antenna or a set top box. Conventional radio and TV sets do not have an uplink capability but 'connected' devices do, either via an external box or integrated in the device itself. It is noted that a stationary TV set may serve as a screen whilst another device, connected to the TV set acts as an actual media player (e.g. media streaming box).
User environments	
In the home **On the move**	There are substantial differences between these two settings in particular in terms of typical user behaviour, reception conditions, and the availability of network infrastructure. An important difference between the two environments is the level of control over the access networks. In the home it lies with the users themselves which access mechanism to choose, as property owners can decide to equip their house as they choose (Terrestrial or satellite antenna, fibre, cable or copper fixed networks). On the move users have to rely to a large extent on access opportunities which lie beyond their control, as they cannot influence the network setup.
NOTE: Whilst the present analysis focuses on audio-visual media services, some aspects may also apply to the distribution of other type of data content such as traffic and weather information, emergency services, software distribution, digital signage, and IoT.	

The deployment opportunities presented and discussed in clause 8 of the present document seek to enable some or all of the use cases in Table 6, in a technically and commercially sustainable way.

Table 6: Use cases

Use case	Service category	Device category	User environment
1	Linear	Mobile	In the home
2	Linear	Mobile	On the move
3	Linear	Stationary	In the home
4	On-demand	Mobile	In the home
5	On-demand	Mobile	On the move
6	On-demand	Stationary	In the home

7 Enabling the Market

7.1 Objectives of BSPs and BNOs

BSPs are interested to make all their content and services, i.e. linear, non-linear and social media, available everywhere, at all times, for all conceivable usage conditions at affordable costs for both broadcasters and users subject to the regulatory conditions broadcasters have to adhere to. In particular, reaching smartphones and tablets has become more and more important in that context.

Some existing distribution options are not able to reach out to smartphones and tablets directly (traditional broadcasting distribution systems such as DTT, satellite or cable), others are not able to meet broadcaster's requirements such as free-to-air delivery, guaranteed quality of service independent of the size of the concurrent audience and non-prohibitive distribution costs.

NOTE: In a joint EBU-ETSI workshop of 2015, Sveriges Television reported that the split of distribution costs between on-demand and live TV was 15 % to 85 % even though the viewing time split between on demand and live TV was 3 % and 97 % [i.14]. The latest figures provided by Sveriges Television for 2017 highlight the same trend, i.e. on-demand distribution costs of 16 % to provide 7 % of viewing time when compared to live TV.

Independent of the targeted user devices the primary objective of BNOs is to:

- improve technical performance or efficiency;
- better use of the resources (infrastructure, capacity, spectrum);
- meet regulatory requirements.

Independent of the targeted user devices the primary objective of BSPs is to:

- reduce costs;
- enhance quality, availability and reliability of content and services;
- enhance user experience; and
- meet regulatory requirements.

7.2 Market enablers

Whether or not broadcast-broadband convergence enables new services in the future depends on the maturity of several fundamental enablers. They apply both to the case of convergence of network infrastructure and seamless interoperability.

The distribution market for audio-visual services including broadcast services is undergoing dramatic change. New and enhanced services may be demanded and completely new usage scenarios may emerge. To meet these challenges four generic enablers can be identified. These are:

1) technology;
2) spectrum;
3) regulation; and
4) business models.

Identifying technology as an enabler is trivial. If it is not possible to deliver certain media services to certain receiving devices a technical solution is required to do so. Technical development builds on technical specification and standardization. This is pursued in corresponding specification and standardization bodies such as ETSI, ITU, 3GPP, DVB and others.

If a wireless technology is available, spectrum is needed which can be used to operate the necessary communication networks. Even though the battles around spectrum are daily routine in ITU-R and elsewhere, the process to allocate spectrum to given technologies is well known.

Spectrum regulation is the guardrail to keep spectrum usage on the right track. Regulatory rules aim to balance degrees of freedom against variety and mutual protection of telecommunication services.

Media services including audio-visual services and Electronic Communication Services are also subject to other forms of regulation. These include sectors and issues such as telecommunication, copyright, competition, public service media, consumer protection, privacy and data protection; and net neutrality. In Europe the European Commission defines a common framework through a set of Directives. These are:

- the Framework Directive which establishes a harmonized framework for the regulation of electronic communications services, electronic communications networks, associated facilities and associated services, and certain aspects of terminal equipment to facilitate access for disabled users;
- the Access Directive which harmonizes the way in which Member States regulate access to, and interconnection of, electronic communications networks and associated facilities;
- the Authorization Directive which is to implement an internal market in electronic communications networks and services through the harmonization and simplification of authorization rules and conditions;
- the Universal Service Directive which concerns the provision of electronic communications networks and services to end-users with the aim to ensure the availability of good-quality publicly available services throughout the European Union; and
- the Directive on Privacy and Electronic Communications which aims at the harmonization of the national provisions required to ensure an equivalent level of protection of fundamental rights and freedoms, and in particular the right to privacy and confidentiality.

These Directives build the overarching framework of European regulation. The European regulation is currently under review in the so called Electronic Communication Code, which aims to refresh the directives above and group them together in a single regulation.

AV content carried over electronic communications networks is regulated by the Audio-Visual Media Service Directive (AVMSD) [i.6]. The AVMSD governs EU-wide coordination of national legislation on all audio-visual media; both traditional TV broadcasts and on-demand services. The AVMSD is currently under review.

All this is relevant in its own right. However, technology, spectrum and regulation are all fuelled by commercial interest. The existence or the expectation of a viable business model is the fundamental driver. In this respect, mutually beneficial business arrangements between different parties are the key to unlock the path to new solutions.

Media services basically have four distinct areas of business activity. These are:

- production and provision of content;
- distribution of content on a variety of platforms;
- business activities derived from the consumption of that content;
- provision of technology to produce, distribute and consume services.

New ways of distributing media services to users are only successful if all players along the value chain become part of a win-win situation. Therefore, it may be necessary to elaborate on potential business arrangements between all involved parties.

It should be obvious that distribution of audio-visual content and services does not come for free. However, there are a huge variety of different arrangements with respect to how distribution is enabled and paid for. Content distribution is the link between content and service generation on one side and consumption on the other side. Building and operating distribution networks requires huge investments and usually entails large operational costs. Any content provider making use of a dedicated distribution network has to pay in one way or the other for content carriage.

In principle, there are potentially two different sources of revenue for network operators. The first source are the content providers who want to make sure that their products arrive at their customers in a clearly defined way and under the regulatory and economic conditions they have to adhere to. The other source of income is the customers of the network operator who seek access to various types of content. Some network operators run one sided business models, for example FTA services are delivered on networks payed for by BSPs. Other network operators run 2 sided business models, gathering revenue both from BSPs and from end users.

7.3 Business arrangements and opportunities

7.3.1 Business arrangements

There are several basic forms of business arrangements between content providers and network operators. Most of them are in place already today in a variety of forms. Figure 3 shows the different business relations.

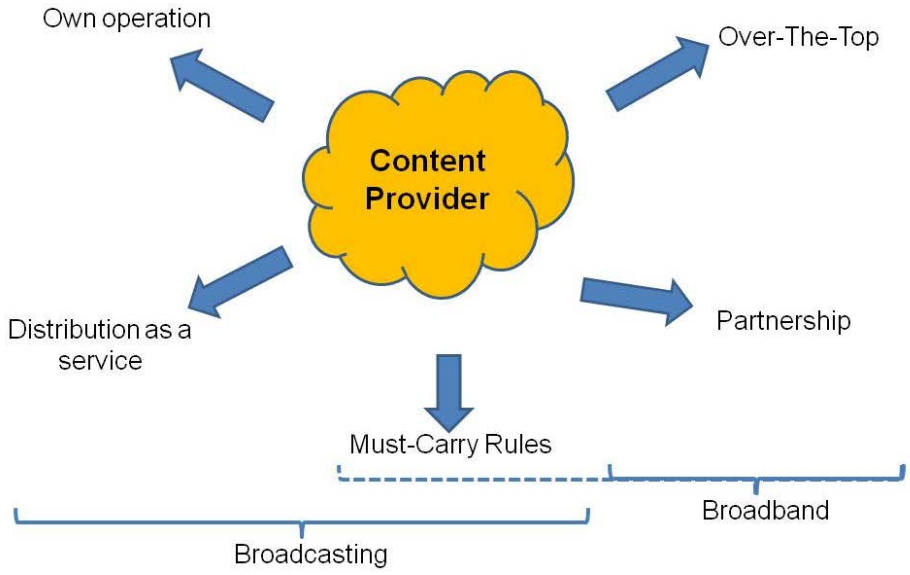

Figure 3: Different business arrangements between content providers and network operators

NOTE: Must-carry rules have been applied mainly in broadcasting networks but there are also cases where this has been extended to broadband networks.

The different business arrangements can be sketched as follows:

1) Self-owned and operated networks:

   - Broadcasters have owned and operated terrestrial broadcasting networks in order to distribute their linear TV and radio programmes. Whether or not broadcasters are in a position to operate their own independent broadband networks to serve their users is yet to be seen.

2) Distribution as a service:

   - Content providers may decide to contract for the distribution of their content, linear and non-linear, from a dedicated network operator. The characteristics of the distribution, i.e. what content, for which devices, across which areas, at what QoS, etc., have to be defined.

3) Must-carry obligations:

   - A regulator may decide to impose must-carry obligations in order to safeguard the availability of certain content over certain networks. Typically, this is applied in cable networks for certain linear programmes. The extension of must-carry rules for linear services on broadband has not been resolved so far. There are on-going discussions to extend must-carry rules to non-linear content and services.

   - For any service delivered over the open internet, net neutrality regulations apply.

4) Partnership:

- In this model, the content provider makes its content available to a network or platform operator subject to certain conditions such as guaranteed QoS, no overlays, etc. The content provider may not pay for distribution to the consumer. The content typically is provided to consumers as a package of channels for a subscription revenue. Different revenue sharing models could be agreed.

- Over the fixed networks, two-sided business models where revenues for the service provider are coming both from the customer base and from the content provider, have emerged through managed video services such as IPTV. Such two-sided business models, monetising the QoS, could be extended to the delivery of video to mobile devices.

5) Over-the-top:

- In this case the content provider makes his content available to the public on the open internet. The content provider does not pay for the full distribution cost, apart from uploading and hosting content and CDN services. The network operator only provides connectivity. Internet connection costs are to be borne by users.

Arrangements 1 - 3 are traditionally used in connection with broadcasting networks such as terrestrial, satellite and cable while 4 and 5 have emerged in the context of broadband networks. However, the boundaries between the different arrangements are blurring as broadband networks gain more influence. Also, similar elements may appear under different arrangements. In the case of distribution over traditional cable networks for example both distribution as a service and partnership elements may be part of an arrangement between content provider and network operator. On the broadband side, the case of audio-visual service platforms such as Netflix may show elements of partnership and OTT.

It should be noted that the current regulatory framework allows a regulator to request the delivery of a specific service when delivering an individual right to use spectrum, especially when such service enables the fulfilment of a general interest objective such as the promotion of cultural and linguistic diversity and media pluralism, for example by the provision of radio and television broadcasting services [i.8].

The details of the business arrangements between BSP and network operator have to reflect the requirements of all involved parties. On one side the business opportunity has to be attractive while on the other side costs incurred on content providers or users have to be bearable. It seems to be clear that the combination of broadcasting and broadband distribution elements may open the door to offer services beyond the traditional linear or strictly non-linear offers, e.g. downloads or streaming. In particular, aspects such as geo-localization and personalization may prove to be vital features to drive the development of successful business arrangements.

In general terms, it seems to be evident that the prospective revenues may trigger progress in the fields of technology progress, spectrum availability and regulatory framework provision more efficiently than anything else.

7.3.2 Innovative advertising revenue opportunities

While convergence could take the form of innovative business arrangements, it could also simply lead to additional benefits for current business arrangements, in particular in terms of advertising.

A number of deployment opportunities in clause 8 treat video stream data as separate segments as opposed to the continuous stream of bits used in MPEG 2 transport streams. As such it makes local or personalized insertion of content such as adverts much easier.

This technology innovation provides opportunities for new advertising models in a number of ways by adapting broadcasts to include regional and targeted data.

A selection of these adverts can be delivered within the broadcast stream, pre-loaded on the viewing device or accessed from the cloud. Selection of the relevant advert is then triggered via various mechanisms so that it is based on the viewing circumstances at the time.

Another method for targeting advertising is via geographic location.

Targeted advertising and targeted content are enabled by an IP return channel, meaning that devices are able to determine their location and potentially the identity of the user, and can relay that information to the service provider.

An IP return channel also means that measurements of advertising delivery are possible as well as gathering demographic information about the viewer that experienced the advert (subject to viewer opt-in).

Broadcasters can benefit from audience measuring tools that can be enabled by the device's IP connection as described in ATSC 3.0 guide [i.13].

7.3.3 Operating several business arrangements concurrently

Convergence may also be a means to facilitate the operation of several business arrangements in parallel, for example OTT and own operation in parallel.

One issue for broadcasters is supplying content to multiple platforms in multiple formats. The move to software-based encoding gives broadcasters the flexibility to address the multiple codecs and frame rates used in broadcast and OTT profiles all at the same time. From a single encoding unit, operators can support existing technologies with MPEG-2 today, and enable HEVC with broadcast and OTT profiles now and into the future. Moreover, such technology allows a faster turnaround to new software features, introducing additional gains in video quality improvements.

7.4 Pre-requisites for viable business arrangements

A prerequisite for deciding on a viable business arrangement between content provider and network operator is a proper and serious analysis of the suitability of the distribution mechanism a network operator is offering. From a BSP point of view there are four different basic criteria which have to be crosschecked against the distribution option under consideration. These are:

1) Technical capability
2) Reach
3) Costs
4) Prominence

The first issue is if a given distribution mechanism is technically capable to deliver audio-visual content and services at all. Does the mechanism provide sufficient capacity to cope with a given amount of services? Can these services then be distributed while respecting pre-defined quality of service requirements? Furthermore, can aspects beyond purely QoS, such as integrity of the signal be guaranteed? Finally, is the envisaged distribution option scalable to cope with increasing service offers?

Reach is a very important aspect for BSPs. Reach has to be distinguished from coverage. The latter describes for example the shape and size of a geographical area in which users can access services subject to employing adequate receiving installations and devices. This refers to everyone inside that area. Reach means the actual set of users who are indeed enjoying the offered services, in other words the size of the actual audience. The difference between coverage and reach can also be due to the fact that people are using devices (such as smartphones and tablets) which do not provide access to certain networks. Furthermore, if services are offered free-to-air but a distribution option does not support it, then this may be an important argument not to use this service. The receiving conditions are another element which are important for reach. Is it possible to make use of services only outdoors or also indoors, is it necessary to employ fixed receiving installations or is portable handheld or even true mobile reception possible?

Obviously, technical capability and reach are important but even if all is as desired but the associated costs for distribution are not bearable then the corresponding distribution option is not viable. In addition to distribution costs content providers may also have an interest to limit the costs imposed on users. In any case, costs on both sides have to be predictable and controllable.

In times when access to content and services is not only offered through dedicated networks but also on the basis of platforms of various kinds making use of OTT distribution mechanisms, prominence and findability of content and services is of utmost importance for content and service providers. This is usually closely linked to the existence of a gatekeeper which may play a crucial role for the viability assessment of a considered distribution option. An important question may be if prominence and findability can be guaranteed by means of regulatory instruments such as must-carry obligations.

8 Deployment opportunities

8.1 Introduction

Broadcast Service Providers (BSPs), Broadcast Network Operators (BNOs), Mobile Electronic Communication Service Provider (MECSPs) and Mobile Infrastructure Operators (MIOs) have been investigating convergence of mobile and broadcast technologies for over ten years. The deployment opportunities presented hereafter have been identified, based on these investigations.

In the following clause, each deployment scenario is assessed against the goal of delivery of linear and non-linear AV services and broadcast related social media to users using different devices in mobile and stationary receiving conditions. The advantages/disadvantages of each deployment opportunity to each actor is also analysed.

These opportunities could enable BSPs to:

- improve their reach to mobile terminals;
- leverage an integrated unicast/broadcast platform, with a broadcast component supporting free-to-air delivery, QoS and coverage control;
- gain access to customer relationships and an integrated payment platform.

These opportunities could enable MECSPs to:

- play a role in the video delivery service, instead of being restricted to the data delivery service;
- get access to high quality content through partnership, rather than through direct involvement in the content business.

These opportunities could enable MIOs to:

- better manage the rise of video content over their networks;
- improve functionalities of their networks, e.g. exploiting a broadcast mode for firmware updates to mobile devices.

These opportunities could enable BNOs to:

- expand their addressable market and generate additional sources of revenue by delivering services to mobile devices.

8.2 Deployment opportunities

8.2.1 Deployment opportunity 1: Device caching - unicast

Concept

Content is available over the internet (unicast connection). Mobile devices can store this content for later off-line consumption by mobile users. Content can be stored either in pull or push mode.

Pre-requisites

- Relevant service is made available on the internet/in the cloud.
- Corresponding app is downloaded and installed on devices.
- Mechanisms are defined to confidently predict which content is required to be cached and at which locations.
- Mechanisms are defined to clear cached content when required, e.g. to obey content right agreements on the device.

- Devices have sufficient memory available to store adequate volume of AV content.
- Users consent to content being cached automatically on their devices.

Assessment vs Target

The opportunity delivers exclusively selected non-linear AV services.

Selected Non-linear AV services are available to any devices capable of broadband connection and the content can be consumed with perfect QoS in any environment.

Pros and Cons

Table 7: Deployment opportunity 1 pros and cons

	Pros	Cons
BNO	Lower pressure to deliver mobile services on broadcast spectrum.	May lead to reduced demand for linear services.
BSP	No need for broadcast infrastructure to reach out mobile devices. Cached content delivered to specific device: opportunity for targeted advertising.	Service limited to cached content. No linear service.
MIO	Less traffic on mobile networks.	Less traffic on mobile networks.
MECSP	Potentially, cached content could increase traffic.	Broadcast content reaches device and reduces consumer demand for mobile services.
Overall	Quality cached content, anytime anywhere.	Need a reliable (timely and appropriate) caching mechanism.

Overview

Network caching uses prediction models of user preferences to cache content at a personal device level. Content is downloaded at off-peak times from a single source or a combination of sources. Live content cannot be preloaded, therefore caching only addresses non-live content.

One big advantage of this solution is that it requires very little pre-requisite, i.e. could be deployed almost immediately, with very little requirement for alignment of several actors.

8.2.2 Deployment opportunity 2: Device caching - broadcast

Concept

Content is available through caching on either the mobile device or intermediate caches (e.g. home gateway). Content is primarily cached through broadcast from the broadcast network, however a device can also retrieve content through a unicast connection. The caching mechanisms involves both broadcast (push) and unicast (push and pull). Content is cached for later off-line consumption by mobile users.

Pre-requisites

- Relevant service is made available on the internet/in the cloud and by means of the broadcast network.
- Caches and user devices have a broadcast receiver and sufficient memory available to store adequate volume of AV content.
- Corresponding app is downloaded and installed on devices.
- Mechanisms are defined to confidently predict which content or package of content is required to be cached and at which locations.
- Mechanisms are defined to clear cached content when required, e.g. to obey content right agreements on the device.
- Users consent to content being cached automatically on their devices.
- BSPs find a business model to pay for delivery cost.

Assessment vs Target

The opportunity delivers exclusively selected non-linear AV services. Linear services and social media are excluded.

Selected Non-linear AV services are available to any devices capable of broadcast and broadband connection and the content can be consumed with perfect QoS in any environment.

However, the service is only available without requiring user to pay for connectivity for devices with broadcast receivers in the area of coverage of the broadcast network. Outside that coverage area, a unicast connection is used and the user is paying for it.

Pros and Cons

Table 8: Deployment opportunity 2 pros and cons

	Pros	Cons
BNO	Additional use of HPHT infrastructure.	Opportunity cost, alternative to live channel.
BSP	Cached content delivered to specific device: opportunity for targeted advertising. Common broadcast infrastructure to reach out customers of all MECSPs.	Service limited to cached content. Broadcast network upgrade needs to be paid by BSP. Limited coverage.
MIO	Less traffic on mobile networks.	Less traffic on mobile networks.
MECSP	N/A	Broadcast content reaches device and reduces consumer demand for mobile services.
Overall	Quality cached content, anytime anywhere.	Business model still to be defined.

Overview

Network caching uses prediction models of user preferences to cache content at a personal, a private group or a public level. Content is then downloaded at off-peak times from a single source or a combination of sources. Live content cannot be preloaded, therefore caching only addresses non-live content.

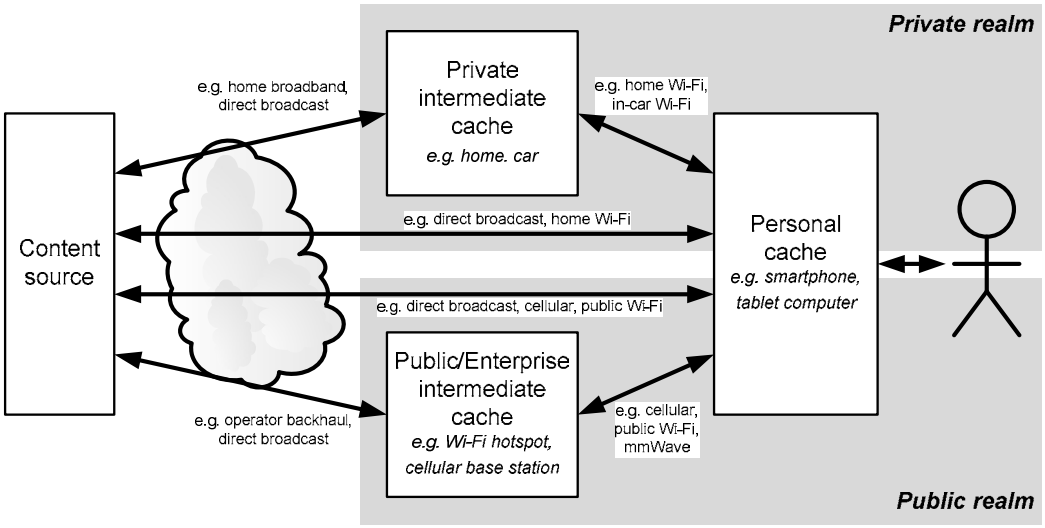

Figure 4: High level caching architecture (Source: BBC)

Figure 4 shows the different scenarios where caching could conceivably take place [i.10].

A use case enabled by the architecture above could be where a personal cache, such as a mobile, handset could contain a DTT receiver and directly receive broadcast content. The content could be stored for later consumption. This could be beneficial when planned viewing is likely to take place in areas where DTT coverage may not be optimal e.g. when on a train or other vehicle. In this example the service provider is the BSP and the user would choose i.e. to pull, the content from the broadcast network.

Alternatively, BSP and MESCPs could work together to provide targeted content to mobile devices with a view to reducing video traffic load on mobile networks. In this case, designated content is pushed to caches via broadcast delivery e.g. DTT or eMBMS, for later consumption. If the caches are intermediate, such as in a public transport hub, then some devices may use WiFi to download the content, which would reduce cellular network traffic.

There are many other use case examples that could be realized involving the broadcast caching concept, and it would not be possible to envisage or specify them all in the present document. For example, the architecture could utilize caches in homes, vehicles, cellular base stations, and could involve many combinations of stakeholders and service providers to provide the content.

8.2.3 Deployment opportunity 3: DTT receiver in handsets

Concept

DTT is used to transmit live linear broadcast content from BNO networks to mobile devices that contain the necessary receiver capabilities.

Pre-requisites

- BNO networks support adequate broadcast standard and are designed to deliver to mobile/portable devices.
- Mobile terminals are upgraded with DTT receiving capabilities.
- BSPs find a business model to pay for delivery cost.

Assessment vs Target

The opportunity delivers linear services. Non-linear AV services and social media are not in the scope of the present document.

Devices with DTT capability can receive the service in the area of coverage of the network.

Pros and Cons

Table 9: Deployment opportunity 3 pros and cons

	Pros	Cons
BNO	Additional use of DTT infrastructure.	Network may need re-planning for mobile devices.
BSP	Common broadcast infrastructure to reach out to customers of all MECSPs.	No interactivity, non-linear or on-demand services.
MIO	N/A	Potentially less traffic on mobile networks.
MECSP	Cost of delivering content is reduced.	Broadcast content reaches device and reduces consumer demand for mobile services.
Overall	Technology available, e.g. in Thailand, designed for mobility.	Device penetration questionable. Approach based on regional broadcast standards. Indoor coverage questionable.

Overview

There are a variety of ways to deploy DTT, these include DVB-T/T2 and DVB-T2 Lite [i.15], ATSC 3.0 ([i.16] and [i.17]), ISDB-T, T-DMB and DTMB-A.

DVB-T/T2 is deployed in over 150 countries worldwide. DVB-T2 Lite uses a selection of the full T2 functionality to tailor it towards mobile use cases. This is done by using features such as robust code rates and short FEC frames to reduce receiver power requirements. The benefit of this is less demand on battery life compared to a full DVB-T2 profile, making it well suited for smartphones and tablets. In addition, T2 or T2-Lite in combination with HEVC technology would allow for more efficient use of the available bandwidth.

8.2.4 Deployment opportunity 4: Hybrid broadcast broadband at home

Concept

Standards such as ATSC 3.0 ([i.16] and [i.17]) and HbbTV [i.18] have been developed to offer hybrid services combining linear and non-linear content.

Linear content is typically delivered through broadcast networks while non-linear content presumes a return channel to allow the user to select additional related content. The latter is typically provided through broadband networks. Linear content may also be delivered point-to-point via unicast this is outside the scope of the present document.

The aim is to reach viewers at home on mobile devices such as tablets and smartphones as well as first screen TVs and to enable a new interactive and personalized viewing experience that can appeal to a wide demographic.

Pre-requisites

- Customers acquire HbbTV or ATSC 3.0 equipment (gateway/receiver/antenna).
- On portable devices, corresponding app is downloaded and installed.
- User pay for the HbbTV receiver, the broadband connectivity to access the interactive content.

Assessment vs Target

The opportunity delivers linear and non-linear AV services as well as social media. It also enables second screen synchronization.

Mobile devices can receive the service within the home network coverage of the HbbTV receiver.

Pros and Cons

Table 10: Deployment opportunity 4 pros and cons

	Pros	Cons
BNO	Increased use of current network/service.	N/A
BSP	No need for broadcast infrastructure to reach out to mobile devices. Both linear and non-linear services. End to end control of offering. Targeted advertising.	Service availability controlled by end-user (no FTA) and limited to in-home.
MIO	N/A	N/A
MECSP	N/A	N/A
Overall	Access to HbbTV services on Smartphones and tablets.	N/A

Overview

Hybrid broadcast and broadband technologies are now available such as HbbTV or are in early deployment stages such as the new ATSC-3.0 standard. On mobile devices, the services can be received via a broadband network and would support interactivity with large screen. This enables new possibilities for the viewers as well as opportunities to optimize delivery from the content provider perspective.

One big advantage of this solution is that it can be deployed, with very little requirement for alignment of several actors. HbbTV is deployed already in many countries.

8.2.5 Deployment opportunity 5a: Standalone LTE Downlink Only - HPHT

Concept

Leveraging a high power, high tower or medium power, medium tower broadcast infrastructure to deliver audio-visual content to mobile devices. The broadcast network is deployed under the same conditions as current DTT networks.

This approach assumes the use of the existing DTT infrastructure for the delivery of content to mobile user devices. Mobile Electronic Communication Service Providers are not involved in the deployment and operation of the service.

Pre-requisites

- LTE broadcast is further enhanced to support deployment over HPHT.
- An agreement is reached between BSPs and BNOs on operational and business models. BSPs fund the deployment.
- Mobile terminals are upgraded to support the adequate frequency range (unless it is part of an existing MFCN band) and support reception of 2 parallel LTE signals.

This scenario would have no direct impact on the cellular network configuration.

Assessment vs Target

The opportunity delivers exclusively linear AV services.

The service is available to devices supporting the new frequency range in the area of coverage of the network.

Pros and Cons

Table 11: Deployment opportunity 5a pros and cons

	Pros	Cons
BNO	Additional use of HPHT infrastructure.	Additional equipment needed, possible re-planning of network for improved reception.
BSP	Common broadcast infrastructure to reach out to customers of all MECSPs.	No interactivity, non-linear or on-demand services. Broadcast network upgrade needs to be paid by BSP. Device penetration is questionable.
MIO	N/A	N/A
MECSP	N/A	N/A
Overall	Access to mobile devices with linear live content.	Business and operating model still to be defined. Limited indoor mobile coverage.

Overview

LTE release 14 introduced receive only mode, enabling reception of a broadcast stream over an independent DL network, with no SIM card. Currently, HPHT support in LTE release 14 is limited and needs to be improved in the future to cover this scenario.

8.2.6 Deployment opportunity 5b: LTE Downlink Only - Overlay

Concept

Integrating a high power, high tower or medium power, medium tower broadcast infrastructure with cellular networks (tower overlay) [i.11], [i.12]. The broadcast network is deployed under the same conditions as current DTT networks.

This approach assumes the use of the existing DTT infrastructure for the delivery of content to mobile user devices. Mobile Electronic Communication Service Providers are involved in the deployment and operation of the service.

Pre-requisites

The key pre-requisites are that:

- LTE broadcast is further enhanced to support deployment over HPHT.
- Synchronization issues between cellular and broadcast network are resolved.
- An agreement is reached between BSPs MECSPs and BNOs on operational and business models. MECSPs and BSPs fund the deployment.
- Mobile terminals are upgraded to support the adequate frequency range (unless it is part of an existing MFCN band) and support reception of 2 parallel LTE signals.

Deploying Tower overlay would have limited impact on the cellular network configuration.

Assessment vs Target

The opportunity delivers exclusively linear AV services.

The service is available to devices supporting the new frequency range in the area of coverage of the broadcast network. Outside of the broadcast network coverage, the existing mobile networks deliver the service.

Pros and Cons

Table 12: Deployment opportunity 5b pros and cons

	Pros	Cons
BNO	Additional use of HPHT infrastructure.	Additional equipment needed, possible re-planning of network for improved reception.
BSP	Common broadcast infrastructure to reach out customers of all MECSPs.	No interactivity, non-linear or on-demand services.
MIO	N/A	Potentially Less traffic on mobile networks.
MECSP	Common infrastructure may reduce price of broadcast.	Common infrastructure partially prevents differentiation. Need to rely on several providers (MIO and BNO) for service delivery.
Overall	Cellular traffic offloaded to BNO providing network optimization.	Business and operating model still to be defined.

Overview

LTE release 14 introduced receive only mode, enabling reception of a broadcast stream over an independent DL network, with no SIM card. Currently, HPHT support in LTE release 14 is limited and needs to be improved in the future to cover this scenario.

RED Regular LTE cellular network: unicast, eMBMS

GREEN Large cells LTE downlink network: broadcast and multicast

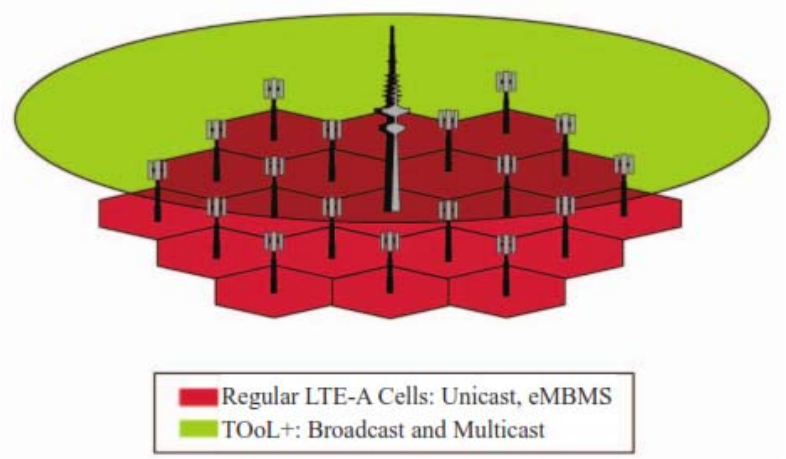

Figure 5: Tower OverLay over LTE+ (Tool+) concept illustration

8.2.7 Deployment opportunity 6: Standalone LTE Downlink Only - Cellular

Concept

BSPs would deploy LTE downlink only service on spectrum dedicated to broadcast services, in partnership with an MIO. The spectrum can also be one block of an MFCN band (e.g. L-band), set aside for broadcast purposes, in a similar manner to cases where MFCN spectrum is set aside for PPDR purposes.

Pre-requisites

- A mobile network needs to be upgraded to support the new frequency band and functionalities.

- Terminals support the new frequency band and LTE broadcast functionalities.
- An agreement is reached between BSPs and one MIO on operational and business models.
- LTE Release 14 is required and the potential for FTA enabled by receive only mode exists.

Assessment vs Target

The opportunity delivers linear AV services. For non-linear AV services, as well as social media, the user may use any available broadband connection.

The service is available to all mobile devices supporting LTE broadcast over the MIOs coverage area.

Pros and Cons

Table 13: Deployment opportunity 6 pros and cons

	Pros	Cons
BNO	N/A	N/A
BSP	Access to mobile devices. Mobile coverage. Both linear and non-linear services. Targeted advertising.	Need to rely on an additional service provider (MIO) for service delivery.
MIO	Additional business model. No competition for spectrum between mobile broadband and broadcast.	N/A
MECSP	N/A	N/A
Overall	Consumers get new mobile broadcast services, with indoor coverage.	Business and operating model still to be defined. The scenario may not be applicable in all countries subject to national regulation.

Overview

This opportunity allows broadcasters to reach mobile devices via a dedicated broadcast network.

Working under a broadcast regulatory framework provides certainty to BSPs that there are no gatekeepers and that they remain in control of the service with the potential to reach the whole population. There are also advantages for the MIO deploying the service as the spectrum needs not be acquired and the service is not in competition with mobile broadband services.

The model provides lots of flexibility to adapt to a country specific spectrum and regulatory situation [i.19].

8.2.8 Deployment opportunity 7: LTE broadcast and unicast

Concept

An BSP and an MECSP cooperate to offer managed broadcast services to the MECSP users over ECS mobile frequencies.

Pre-requisites

- An agreement is to be reached between BSP, MECSP and MIO over operational and business models.
- MECSPs accept to comply with relevant broadcast regulation (e.g. potentially must-carry of public service broadcasters).
- MIO network is upgraded to support LTE broadcast [i.20].

Assessment vs Target

The opportunity delivers linear and non-linear AV services as well as social media only to part of the BSP's audience i.e. only to the MECSP's subscribers.

The service is available to all mobile devices supporting LTE broadcast in the MIO's coverage area.

Pros and Cons

Table 14: Deployment opportunity 7 pros and cons

	Pros	Cons
BNO	N/A	N/A
BSP	Guaranteed access to the partner MECSP customers. Mobile coverage. Both linear and non-linear services. Targeted advertising. Zero rating of content may have an impact (depends on business arrangement).	Subscription to an MECSP required. Need to rely on reaching agreement with each MECSP to reach the whole population. MECSP as gatekeeper.
MIO	Additional business model. May reduce unicast video pressure on network.	Competition for spectrum between mobile broadband and broadcast => Mobile broadband QoS is degraded vs competition.
MECSP	Targeted advertising. Reduces price of broadcast content delivery compared to unicast. Potential additional services.	Broadcast usage is in competition with mobile broadband usage. Zero rating offers are under review by regulators (2018). Broadcast regulation may impose must-carry of some broadcast services.
Overall	More spectrally efficient than unicast.	Each MIO provides broadcast services only to its customers. New BSP/MSP+ MECSP business model to be defined.

Overview

MIOs have been considering the deployment of LTE broadcast for some time, purely as a network optimization feature. This is happening in many countries in the world, therefore network and device aspects do not seem to be the limiting factor here.

Some MECSPs are proposing their own offering of AV services, in essence competing with BSPs.

It is unclear why MECSPs have been reluctant to offer AV services as managed services, but, in essence, they could implement this option straight away if they considered that they could derive a positive business case out of it. There have recently been signs of evolution with the rise of offerings such as Sky TV, Netflix, Spotify and Pay TV packages, in partnership between the content provider and the MECSP. With the increase in size and quality of displays in portable devices and improved mobile broadband availability, demand is increasing for AV services in general.

One possible question mark preventing a larger take-up of AV services is the uncertainty around such offers and regulatory review of any zero-rating mechanism.

The cost of mobile spectrum might make this particular deployment scenario difficult to achieve.

8.2.9 Deployment opportunity 8: 5G network slice

Concept

The first vision of 5G (IMT 2020) [i.21] was published in September 2015 by ITU. In January 2016 the joint initiative 5G-PPP from the European Commission and European ICT industry published its whitepaper on 5G and Media & Entertainment [i.5].

The first "5G" standards are Release 15 of 3GPP (http://www.3gpp.org/release-15), which were completed in December 2017. The radio access network of Release 15 is anchored to LTE Rel.14 Core in supplement of LTE Radio, and early 5G deployments are expected to be able to offer all the features of LTE-Broadcast. Therefore, all features of Release 14 (4G/LTE) are available in further 3GPP releases. As 5G unfolds, there are opportunities to develop a 5G broadcast mode. Furthermore, BSPs and MSPS may take advantage of network slicing in order to employ dedicated network resources to deliver AV services. 5G Network Slicing is referenced in [i.22].

Pre-requisites

- 5G broadcasting technology beyond Release 15 should provide further enhancements to LTE Broadcast.
- MIOs have to deploy 5G broadcast capabilities.
- MSP, BSP, and MIO find an appropriate business and operational model.
- Appropriate regulatory models may be required, for example with regards to network slicing.

Pros and Cons

This is a long-term opportunity subject to the above-mentioned pre-requisites being met.

The matrix below shows the proposed deployment opportunities and how they relate to the different definitions of convergence defined earlier in the present document.

Table 15: Summary of deployments opportunities

	Device caching - unicast	Device caching - broadcast (see note)	DTT receiver in handsets	Hybrid broadcast broadband	Standalone LTE DL only - HPHT	LTE DL only - Overlay	Standalone LTE DL only - Cellular	LTE broadcast and unicast	5G Network Slice
Opportunity	1	2	3	4	5a	5b	6	7	8
Delivery Method	N/A	HPHT	HPHT	HPHT+IP	HPHT	HPHT + Cellular	Cellular	Cellular	Cellular
Service provider(s)	BSP/MSP + MECSP	BSP	BSP	BSP	BSP	BSP + MECSP	BSP	BSP/MSP + MECSP	BSP/MSP
Infrastructure	MIO	BNO	BNO	BNO+ISP	BNO	BNO + MIO	MIO	MIO	MIO
Regulation & Spectrum	ECS	BS	BS	BS+ECS	BS	BS	BS	BS+ECS	New ?
Pros	Quality cached content, anytime, anywhere.	Quality cached content, anytime, anywhere.	Technologies available.	Second screen synch. Improved service e.g. on-demand.	Access to mobile devices with linear live content.	Cellular traffic offloaded to BNO.	Consumers get new mobile broadcast service with indoor coverage.	Linear and on-demand service. More spectrally efficient than unicast.	Linear and on-demand services tailored to BSP/MSP requirements.
Cons	Needs a reliable caching mechanism.	More storage required on devices. Broadcast receivers in devices.	Lack of device penetration and indoor coverage. No world standard.	No compatible hybrid mobile devices.	Limited indoor mobile coverage. Linear service only.	Reliance on several providers (MIO,BNO) for service delivery.	Business models to be defined. Spectrum availability.	New BSP/MSP+ MECSP business model to be defined.	New infrastructure for BSP/MSP, regulatory uncertainty.
NOTE: Opportunity 2 gives one example of a possible use for caching using broadcast delivery, clause 8 of the present document highlights further use case examples.									

9 Conclusions

In the present document, mobile-broadcast convergence has been considered for the distribution of audio-visual media content and services including linear broadcast radio and TV services.

Convergence has been examined on numerous occasions in the past in light of the limitations of mobile and broadcast services. Convergence proposals respond to the fact that users so far experience a fragmented situation where broadcast services are available on some devices (typically large screen TVs) and mobile devices are used for other services (for example social media or on demand AV services).

The present document assesses the various opportunities and analyses the reasons why previous attempts have not been successful. It also provides a useful reference and a tool for organizations planning such solutions. Current trends and developments in audio-visual media distribution and consumption could significantly change the scene. It was observed that:

- The growing capabilities of mobile devices have remarkably enhanced the user audio and video experience. As a result, users are increasingly consuming and generating video on mobile devices.
- This contributes to the mounting pressure on mobile networks to accommodate traffic growth in video delivery.
- In recent years, several stakeholders have engaged in R&D activity related to the delivery of live broadcasting to mobile devices and new standards are emerging. For example, several broadcasters have engaged with the 3GPP standardization process in an attempt to ensure future 3GPP networks are suitable for broadcasting Audio Visual content.
- Mergers and acquisitions are occurring between companies in the telecommunications industry, the content industry and the broadcast distribution sector.

The present document further identified several technologies that could enable converged deployment opportunities. These deployment opportunities range from caching content to including DTT receiver in handsets, extending the reach of hybrid broadcast broadband, leveraging LTE solutions with several deployment models, to implementing broadcast as a 5G slice. All these deployment opportunities correspond to an array of different services or different commercial arrangements, as detailed in clause 8.

The list of these deployment opportunities is far from being closed. Two examples of further ongoing activity are 3GPP standardization of 5G and DVB work on the delivery of standalone live TV services over IP. In particular 5G slicing may have an impact not just on technology but also on business models.

ETSI ISG MBC concluded that convergence should enable users to access linear broadcast services:

- on mobile devices;
- without restriction on the amount of content consumed;
- both free-to-air and paid for services;
- with perfect delivery quality;
- in any user environment.

Convergence also covers the existing use cases such as delivery of additional services (e.g. social media, non-linear broadcast services) and consumption on other devices (e.g. large screen TV).

The viability of any given convergence scenario depends on four generic enablers: technology, spectrum, regulation and business models. As an array of technology solutions seem to respond to many potential deployment scenarios, the barrier to convergence seems to rely mostly in the identification of appropriate business models. Today broadcasters already rely on different business models ranging from Over-The-Top delivery to own operation of broadcast networks, and including models such as partnership, must-carry obligations and distribution as a service. Difficulties in identifying the appropriate business model for convergence corresponds partly to a situation where many actors need to collaborate to implement a convergence scenario. Different entities control the audio-visual service, the mobile service, the terminal (mobile or not) and the network (mobile or broadcast).

While benefits for the end users are typically self-evident, the implementation of convergence scenarios is sometimes stalled by issues surrounding questions such as 'Who controls the services?', 'Who owns the customers relationship?' or 'Who benefits the most from convergence?'.

Perhaps even more fundamentally, convergence in itself requires the adoption of innovative business arrangements which partly differ from the economic models currently in use in either the mobile ecosystem or the broadcast ecosystem. Convergence requires us to depart from business as usual, i.e. convergence is disruptive. As such, it is unlikely that convergence scenarios would arise from evolutionary processes.

In conclusion, while convergence has been mostly discussed in terms of innovative technologies, the success of convergence scenario is contingent on three main processes:

- defining the innovative service proposed (placing the end-user at the centre of the conversation);
- identifying the necessary stakeholders and business models acceptable to all of them; and
- establishing an adequate regulatory regime.

The aim of the ISG MBC was not to write a specification, but to analyse a variety of methods by which innovative new convergent services might be provided to the satisfaction of end-users.

The present document suggests many ways in which this can be achieved. It is likely to require a group of stakeholders from different parts of the industry, committed to a common vision for innovative convergent mobile-broadcast services. This would allow the launch of new services that turn these technology opportunities into benefits to all parties.

Annex A:
Authors & contributors

The following people have contributed to the present document:

Rapporteur:
Philip Kelley, Nokia

Other contributors:
Andrew Dumbreck, Andrew Dumbreck Media

Andrew Murphy, BBC

Chris Nokes, BBC

Matt Stagg, BT/EE

Alex Buchan, Digital TV Group

Roland Beutler, EBU

Simon Fell, EBU

Jochen Mezger, IRT

Guillaume Lebrun, Qualcomm

Assunta de Vita, RAI

Richard Moreton, Samsung

Steve Beck, Sony

History

Document history		
V1.1.1	June 2018	Publication